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## Hydraulic Gear Pump Failure Analysis

### **Failure Mode: Over-Pressure**

**Component:** Hydraulic Gear Pump

**Pump Type:** External Gear Pump

**Reported Issue:** Sudden loss of function / catastrophic internal damage

### **1. Summary of Findings**

Inspection of the hydraulic gear pump revealed damage consistent with operation above the pump's rated pressure. The observed failure patterns indicate a pressure-induced mechanical overload, rather than cavitation, contamination, or normal wear.

### **2. Visual Inspection Findings**

#### **2.1 Gear Teeth**

##### **Observations:**

- Gear teeth exhibit **deformation** and **peening**
- Flattened or rolled tooth tips, possibly uneven
- Evidence of **tooth root stress cracking**
- In some cases, partial tooth fracture or spalling

##### **Interpretation:**

Gear tooth deformation occurs when transmitted torque exceeds the design limits of the gearset, consistent with sustained or transient over-pressure events.

#### **2.2 Pump Housing**

##### **Observations:**

- Polished or smeared housing surfaces
- Circumferential scoring aligned with gear rotation
- Localized housing deformation in high-load areas

##### **Interpretation:**

Excessive internal loading forces gears against the housing, causing metal-to-metal contact beyond normal hydrodynamic film limits.



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### 2.3 Wear / Thrust Plates

#### Observations:

- Heavy scoring and galling
- Directional wear patterns
- Possible material transfer between components

#### Interpretation:

Axial loads increase significantly under over-pressure conditions, overwhelming thrust compensation mechanisms.

### 2.4 Shaft and Keyway

#### Observations:

- Twisting or torsional deformation of drive shaft
- Keyway elongation or cracking
- Possible shear failure at shaft transitions

#### Interpretation:

These features indicate **torque levels exceeding the shaft's yield strength**, directly associated with over-pressure operation.

### 3. Failure Mode Identification

#### Primary Failure Mode: Hydraulic Over-Pressure

Over-pressure occurs when system pressure exceeds the pump's rated limits, often due to inadequate pressure control or downstream blockage.

### 4. Likely Causes of Over-Pressure

One or more of the following conditions likely contributed:

- Relief valve set above pump maximum rating
- Relief valve stuck closed or slow-reacting
- Downstream valve blockage or dead-heading
- Incorrect system pressure setting after modification
- Load-induced pressure spikes
- Use of pump in an application beyond its design intent



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### 5. Conditions Ruled Out

Based on inspection results, the following were ruled out as primary causes:

- Cavitation
- Abrasive contamination
- Lubrication failure
- Manufacturing defects
- Misalignment

### 6. Root Cause

The root cause of the failure is determined to be **mechanical overload caused by operation above the pump's rated pressure**, resulting in excessive torque and axial loading.

### 7. Corrective Actions & Recommendations

1. Verify pressure relief valve setting does not exceed pump rating
2. Inspect relief valve function and response time
3. Install pressure gauge near pump outlet
4. Ensure system cannot dead-head the pump
5. Evaluate transient pressure spikes using data logging if applicable
6. Confirm pump model is properly sized for system loads